Fatigue Performance of Biodegradable Magnesium-Calcium Alloy Processed by Laser Shock Peening for Orthopedic Implants

M.P. Sealy, Y.B. Guo, R.C. Caslaru, J. Sharkins, D. Feldman

PII: S0142-1123(15)00276-5
DOI: http://dx.doi.org/10.1016/j.ijfatigue.2015.08.024
Reference: JIJF 3700

To appear in: *International Journal of Fatigue*

Received Date: 16 April 2015
Revised Date: 9 July 2015
Accepted Date: 24 August 2015

Please cite this article as: Sealy, M.P., Guo, Y.B., Caslaru, R.C., Sharkins, J., Feldman, D., Fatigue Performance of Biodegradable Magnesium-Calcium Alloy Processed by Laser Shock Peening for Orthopedic Implants, *International Journal of Fatigue* (2015), doi: http://dx.doi.org/10.1016/j.ijfatigue.2015.08.024

Fatigue Performance of Biodegradable Magnesium-Calcium Alloy Processed by Laser Shock Peening for Orthopedic Implants

M.P. Sealy[a], Y.B. Guo [a*], R.C. Caslaru[a], J. Sharkins[b], D. Feldman[b]

Dept. of Mechanical Eng., The University of Alabama, Tuscaloosa, AL 35487, USA
Dept. of Biomedical Eng., University of Alabama at Birmingham, Birmingham, AL 35294, USA

Abstract

Permanent orthopedic implants made from titanium, stainless steel, or cobalt-chromium alloys cause stress shielding and lead to secondary surgery. Biodegradable magnesium-calcium (MgCa) alloys have the potential to minimize stress shielding as well as eliminate the need for secondary surgery. The critical technical challenge is that magnesium degrades rapidly in the human body. In order to slow the corrosion rate, surface treatments such as laser shock peening (LSP), shot peening, or burnishing have been reported in literature. Each of these surface treatments uniquely alters the surface integrity and consequent fatigue life. Even though surface treatments may be effective at slowing corrosion rates, it is important to ensure that they do not shorten fatigue life. The purpose of this study was to (1) develop a laser shock peening (LSP) surface treatment of a curved surface that adjusts the surface integrity of a MgCa alloy by varying the peening overlap ratio and (2) determine the effect of LSP on the fatigue life. Surface integrity was characterized by topography, microstructure, and microhardness. Fatigue life of laser peened and unpeened samples were measured by rotating bending fatigue tests. It was found that LSP increased the fatigue life of the peened MgCa samples. Implementing LSP at high overlap ratios reduced the surface pile-up which resulted in a higher fatigue life. The fractured surfaces of the peened samples exhibited striation patterns which were more pronounced at higher peening overlap ratios.

Keywords: surface treatment, fatigue, magnesium, biodegradable implant, laser shock peening

[*] Corresponding author. Tel.: +1 205 348 2615; Fax: +1 205 348 6419.
E-mail address: yguo@eng.ua.edu (Y.B. Guo).